Claims:

What is claimed is:

1. A method in a convolutional decoder for calculating branch labels comprising the steps of:

selecting a group of four consecutive states, S_i, S_{i+1}, S_{i+2}, and S_{i+3}, wherein S_i and S_{i+1} have next states S_j and S_k in a first trellis butterfly and S_{i+2} and S_{i+3} have next states S_{j+1} and S_{k+1} in a second trellis butterfly;

loading state S_{i+3} into a convolutional encoder and setting the convolutional encoder input bit to 1, wherein the convolutional encoder parameters include a constraint length K and generator polynomials $G_p[K-2:0]$, wherein p is an index from 0 to p-1 for p-number of generator polynomials used to produce p-number of encoder output bits $[V_{p-1}:V_0]$ and bit G[0] represents a modulo-2 adder connection to the newest bit in an encoder shift register in the convolutional encoder; and

computing a first branch label $BL[V_{p-1}':V_0']$ for the input equals 1 transition from state S_{i+1} to state S_k in the first trellis butterfly using the formula

$V_p' = G_p[K-3] \text{ xor } V_p$

where $G_p[K-3]$ is the K-3 bit of the p^{th} generator polynomial and V_p is the p^{th} bit of the state S_{i+3} encoder output bits $[V_{p-1}:V_0]$.

2. The method in a convolutional decoder according to claim **1** further comprising the steps of:

determining that the convolutional encoder is configured as a recursive convolutional encoder having a feedback polynomial GF[K-2:0];

in response to determining that the convolutional encoder is configured as a recursive convolutional encoder, computing the first branch label $BL[V_{p-1}':V_0']$ for the input equals 1 transition from state S_{i+1} to state S_k using the formula

$$V_p' = G_p[K-3] \text{ xor } GF[K-3] \text{ xor } V_p$$

where $G_p[K-3]$ is the K-3 bit of the p^{th} generator polynomial, GF[K-3] is the K-3 bit of the feedback polynomial, and V_p is the p^{th} bit of the state S_{i+3} encoder output bits $[V_{p-1}:V_0]$.

3. The method in a convolutional decoder according to claim **1** further comprising the steps of:

computing a branch label by setting a branch label for a transition from state S_{i+3} to state S_{k+1} equal to encoder output bits $[V_{p-1}:V_0]$;

computing a branch label by setting a branch label for a transition from state S_{i+2} to state S_{j+1} equal to the branch label for the transition from state S_{i+3} to state S_{k+1}; and

computing branch labels by setting branch labels for transitions from state S_{i+2} to state S_{k+1} and from state S_{i+3} to state S_{j+1} equal to the inverse of the branch label for the transition from state S_{i+3} to state S_{k+1}.

4. The method in a convolutional decoder according to claim **1** further comprising the steps of:

computing a branch label by setting a branch label for a transition from state S_i to state S_j equal to $BL[V_{p-1}':V_0']$; and

computing branch labels by setting branch labels for transitions from state S_i to state S_k and from state S_{i+1} to state S_j equal to the inverse of $BL[V_{p-1}':V_0']$.

5. The method in a convolutional decoder according to claim **1** wherein state indices j and k associated with states S_j and S_k, respectively, are related by the formula

$$k = j + 2^{((K-2)-1)}.$$

6. The method in a convolutional decoder according to claim **1** further including the steps of:

addressing a branch metric register file using two least significant bits of a branch label for the input equals 1 transition from state S_{i+1} to state S_k; and

addressing the branch metric register file using two least significant bits of a branch label for the input equals 1 transition from state S_{i+3} to state S_{k+1}.

7. A branch metric unit for a Viterbi decoder comprising:

a state counter for selecting a group of four consecutive states, S_i, S_{i+1}, S_{i+2}, and S_{i+3}, wherein S_i and S_{i+1} have next states S_j and S_k in a first trellis butterfly and S_{i+2} and S_{i+3} have next states S_{j+1} and S_{k+1} in a second trellis butterfly;

a convolutional encoder loaded with state S_{i+3} and having a convolutional encoder input bit equal to 1, wherein the convolutional encoder parameters include a constraint length K and generator polynomials $G_p[K-2:0]$, wherein p is an index from 0 to p-1 for p-number of generator polynomials used to produce p-number of encoder output bits $[V_{p-1}:V_0]$ and bit G[0] represents a modulo-2 adder connection to the newest bit in an encoder shift register in the convolutional encoder; and

a branch label calculator for computing a first branch label $BL[V_{p-1}':V_0']$ for the input equals 1 transition from state S_{i+1} to state S_k in the first trellis butterfly using the formula

$V_p' = G_p[K-3] \text{ xor } V_p$

where $G_p[K-3]$ is the K-3 bit of the p^{th} generator polynomial and V_p is the p^{th} bit of the state S_{i+3} encoder output bits $[V_{p-1}:V_0]$.

8. The branch metric unit according to claim **7** further comprising:

a mode detector for determining that the convolutional encoder is configured as a recursive convolutional encoder having a feedback polynomial GF[K-2:0];

a branch label calculator responsive to the mode detector for computing the first branch label $BL[V_{p-1}':V_0']$ for the input equals 1 transition from state S_{i+1} to state S_k, when the convolutional encoder is configured as a recursive convolutional encoder, using the formula

$V_p' = G_p[K-3]$ xor $GF[K-3]$ xor V_p

where $G_p[K-3]$ is the K-3 bit of the p^{th} generator polynomial, GF[K-3] is the K-3 bit of the feedback polynomial, and V_p is the p^{th} bit of the state S_{i+3} encoder output bits $[V_{p-1}:V_0]$.

9. The branch metric unit according to claim **7** wherein state indices j and k associated with states S_j and S_k, respectively, are related by the formula

$$k = j + 2^{((K-2)-1)}.$$

10. A data receiver for receiving convolutionally encoded data comprising:

a receiver and demodulator for receiving user data;

a Viterbi decoder coupled to the receiver and demodulator, wherein the Viterbi decoder includes a branch metric calculator that includes:

a state counter for selecting a group of four consecutive states, S_i, S_{i+1}, S_{i+2}, and S_{i+3}, wherein S_i and S_{i+1} have next states S_j and S_k in a first trellis butterfly and S_{i+2} and S_{i+3} have next states S_{j+1} and S_{k+1} in a second trellis butterfly;

a convolutional encoder loaded with state S_{i+3} and having a convolutional encoder input bit equal to 1, wherein the convolutional encoder parameters include a constraint length K and generator polynomials $G_p[K-2:0]$, wherein p is an index from 0 to p-1 for p-number of generator polynomials used to produce p-number of encoder output bits $[V_{p-1}:V_0]$ and bit G[0] represents a modulo-2 adder connection to the newest bit in an encoder shift register in the convolutional encoder; and

a branch label calculator for computing a first branch label $BL[V_{p-1}':V_0']$ for the input equals 1 transition from state S_{i+1} to state S_k in the first trellis butterfly using the formula

$V_p' = G_p[K-3] \text{ xor } V_p$

where $G_p[K-3]$ is the K-3 bit of the p^{th} generator polynomial and V_p is the p^{th} bit of the state S_{i+3} encoder output bits $[V_{p-1}:V_0]$; and

a data output unit coupled to the Viterbi decoder for formatting and outputting the user data.

11. The data receiver according to claim **10** wherein the branch metric calculator in the Viterbi decoder further includes:

a mode detector for determining that the convolutional encoder is configured as a recursive convolutional encoder having a feedback polynomial GF[K-2:0];

a branch label calculator responsive to the mode detector for computing the first branch label $BL[V_{p-1}':V_0']$ for the input equals 1 transition from state S_{i+1} to state S_k, when the convolutional encoder is configured as a recursive convolutional encoder, using the formula

$V_p' = G_p[K-3]$ xor $GF[K-3]$ xor V_p

where $G_p[K-3]$ is the K-3 bit of the p^{th} generator polynomial, $GF[K-3]$ is the K-3 bit of the feedback polynomial, and V_p is the p^{th} bit of the state S_{i+3} encoder output bits $[V_{p-1}:V_0]$.

12. The data receiver according to claim **10** further including an output device coupled to the data output unit for outputting an audible signal.

13. The data receiver according to claim **10** wherein the data receiver is a cellular telephone.